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SECTION 13

PROJECT ECONOMICS

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CONTENTS

13.1	BOTTOM-LINE ECONOMIC MEASUREMENTS	13.1
13.2	THE VALUE OF MONEY	13.1
13.3	DECISION CRITERIA	13.6
13.4	AFTER-TAX CASH FLOWS	13.8
13.5	FINANCING EFFECTS	13.10
13.6	LEASING	13.13
13.7	RATE-OF-RETURN REQUIREMENTS	13.15
13.8	CHARACTERISTICS AFFECTING INVESTMENTS	13.16
13.9	RISK AND REWARD	13.17
	BIBLIOGRAPHY	13.17

13.1 BOTTOM-LINE ECONOMIC MEASUREMENTS

This primer is intended to give a quick introduction to the financial considerations that drive the decisions to start or abandon a project. The *bottom line* on any project is that it is either better or worse than alternative investments. Money is the usual medium for measuring “better” because all the other factors like risk, reputation, and enjoyment, often can be translated into a monetary equivalent.

The decision to start a project, and the selection of the method to finance it, may involve many interrelated factors. Chief among these factors are the values of project costs and receipts, interest rates, possible returns from other projects, tax regulations, and available financing. The remainder of this primer briefly discusses these items and illustrates the economic differences resulting from three different methods of financing a project: (1) 100% financing by the owner, (2) 50% owner’s equity and 50% borrowed debt, and (3) leasing from another owner.

The illustrations herein are intended to convey the certain knowledge that taking shortcuts on economic analysis may lead to an inappropriate decision. This is particularly true when a long-term project, like a new energy production system, is being evaluated against a short-term project, like purchasing specialty machinery for producing a product which has a limited sales life. The correct decision is the one which yields the greatest total value to the owner.

13.2 THE VALUE OF MONEY

Money has no value of its own; its value is proportional only to the goods and services it provides. The amount of goods and services money can provide in a given year relates directly to the relative value of money at that one point in time. If inflation did not reduce the value of money over time, a specified amount of dollars could buy the same set of goods and services in one time as in another. Because of inflation, however, the value of that specific amount of dollars decreases over time; the same amount of money is worth fewer goods and services in later periods. As a result, the decision to start a project should consider both the *amounts* of expenditures and receipts associated with the project and the *timing* of those cash flows.

TABLE 13-1 Relationship of Nominal Dollars to Real Dollars

	Dollars in year of receipt					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Nominal value (actual dollars)	100.00	100.00	100.00	100.00	100.00	500.00
Real value (1984 buying power)	100.00	90.91	82.64	75.13	68.30	416.98
Nominal value (actual dollars)	100.00	110.00	121.00	133.10	146.41	610.51
Real value (1984 buying power)	100.00	100.00	100.00	100.00	100.00	500.00

The terms used to express the effect of time on the value of money are (1) *real dollars* and (2) *nominal-year dollars* or *nominal dollars*. Nominal dollars refer to the amount of dollars received or spent in a given year. Because of inflation, a dollar received in year *X* will be worth more or less than a dollar received in year *Y*. In order to compare the two, the real purchasing power of a year *X* dollar must be compared against the real purchasing power of a year *Y* dollar. It makes no difference whether (1) year *X* dollars are converted into the number of year *Y* dollars that have the same real purchasing power, or (2) year *Y* dollars are converted into year *X* dollars. If more convenient, both can be converted into equivalent dollars of some other nominal year.

In order to consider the effects of inflation on a project, all cash flows from each of the various years of the project should be expressed on a directly comparable, common year basis so that their relative values can be considered. To accomplish this, the *nominal-year dollars* of cash flow in each future year are converted to *constant-year dollars* by *discounting* their value back to that of one common year.

If inflation is running at 10% per year, the relative value of \$100 in hand in year 1 will be \$110 in year 2 or \$121 in year 3, etc. Likewise, future values must be discounted to obtain their value today. In other words, the *real value* of \$146.41 (nominal-year dollars) received 4 years away is only \$100.00 in year 1 dollars. The illustration in Table 13-1 uses such a 10% *discount rate* to calculate the real value (in constant year 1 dollars) of future nominal-year dollars for each year. The first two rows show the decline in real value (the ability to purchase goods and services) of a stream of \$100 annual receipts. The second two rows show the increase in annual dollar receipts required to maintain the same real income in each future year.

If a project is to be a success, the sum of its real costs and real returns must be positive enough to overcome any uncertainty about the occurrence of future costs and returns. The *present value* of a future income stream (or cost stream) is the sum of the *real values* of the individual future receipts (or costs). The *net present value* (NPV) of a project is calculated by subtracting the present value of project costs from the present value of expected project returns. The example in Table 13-2 illustrates both the time value of money and the process of calculating the net present value of a project. The nominal dollar values of cash stream A are identical, but in reverse order, to those in cash stream B.

In this illustration, if B is a revenue stream and A is a cost stream, the project makes some money in 5 years; the NPV is a positive value of \$30. If only the nominal dollar flows are considered, the project appears to break even; the *nominal return* over the life of the project is zero. However, that

TABLE 13-2 Calculation of Net Present Value

Cash stream	Yearly cash flow, \$								Total cash flow, \$	
	Year 1		Year 2		Year 3		Year 4		Nominal value	Present value @ 10% discount rate
	Nom.*	NPV [†]	Nom.	NPV	Nom.	NPV	Nom.	NPV		
A	100	91	150	124	180	135	220	150	650	500
B	220	200	180	149	150	113	100	68	650	530
B – A	120	109	30	25	–30	–22	–120	–82	0	30

*Nom. = nominal value.

[†]NPV = net present value.

is *not* the case in real terms. Because of the time difference in the cash flows, the project earns a net positive real spendable return.

In this example, the project begins to lose money in year 3. Obviously, if the project can be stopped at the appropriate time, more income will be retained by the owner. If not, the project may still be the best alternative, especially if the scenario of Table 13-2 is the worst expected case and the “best guess” case would return significant profits. Whether this particular project would be started depends on such factors as the relative returns that can be earned from alternative projects, the relative risk of each project, the availability of financing, and the type and usefulness of tax advantages.

Annual Charges. It is desirable to have a convenient method of calculating the annual costs of capital investments made in an alternative scheme. Fortunately, this often can be done realistically by using a level carrying charge which is expressed as a percentage of the original investment.

The total revenue requirements of a piece of equipment are the sum of the annual charges for

1. Return on investment
2. Depreciation
3. Income tax
4. Property taxes
5. Insurance
6. Operating and maintenance expenses

The first five of these charges can conveniently be estimated as a percentage of original investment. The operating and maintenance charges should be estimated separately for each project because they do not relate to capital investment as a percentage.

Level Annual Carrying Charges. The level annual carrying charge is the percentage by which the capital investment can be multiplied to determine its annual cost on a uniform basis. The value of this carrying charge is very much dependent on the expected life of the piece of equipment because depreciation varies in accordance with life expectancy. A method of obtaining the level annual carrying charge is as follows: (1) calculate the sum of the annual charges for return on investment, depreciation, income tax, property tax, and insurance for each year of the expected life of the piece of equipment, (2) use the appropriate present-worth factor with each annual cost to convert the annual cost to a present-worth value; (3) sum up these values to obtain the total present worth of the annual carrying charges; and (4) multiply the total present worth by the capital recovery factor (see Fig. 13-1) to get the equivalent uniform annual charge. Figure 13-2 shows graphically the actual and equivalent carrying charges for a capital investment of a piece of equipment with a 5-year life and an assumed 8% cost of money.

The total carrying charges with 8% cost of money for various service lives are estimated as follows:

Years of life	Level annual total carrying charge in %
5	30.82
10	20.59
15	17.44
20	16.04
25	15.34
30	14.96
35	14.76
40	14.67
45	14.63
50	14.63

13-4 SECTION THIRTEEN

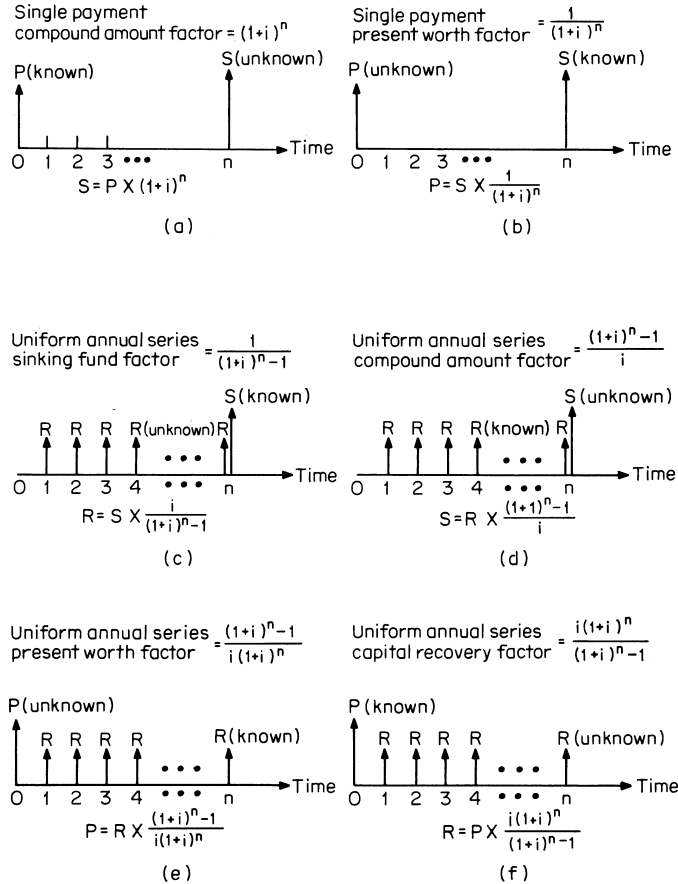


FIGURE 13-1 Graphic interpretations of compound interest factors.

Operating and Maintenance Expenses. This cost component varies with the nature of the project. It is usually not a direct function of the capital invested and may have an inverse tendency. That is, alternatives often exist for higher capital expenditures to reduce operating costs. Therefore, it is *not* expressed as a percent of capital investment in most cases. Nevertheless, it should be included in annual costs.

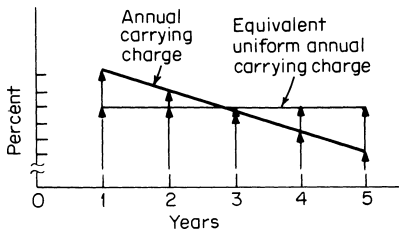


FIGURE 13-2 Representation of carrying charges.

Study Period. When determining the economic comparison of alternatives by comparing the present worth of annual costs, the study period should be taken to the point that the alternatives are equivalent in capability. If this is not practical, the study should be taken so far into the future that the difference in present worth would be insignificant.

Economic Evaluations. A simple example will show a comparison between two alternatives. Let CC represent the capital investment multiplied by the level annual carrying charge, operating and maintenance ($O\&M$) represent annual operation and maintenance, and RR represent the total revenue requirement necessary annually to carry the project. A pad-mounted sectionalizing switch is needed for an underground circuit. The choice is between two manufacturers who can supply the switch but with different characteristics as follows:

	Mfr. A	Mfr. B
Installed cost	\$3600	\$3300
Operating and maintenance	50/year	100/year
Expected life	30 years	20 years

There is no salvage value at end of life. Determine which alternative is less expensive.

The first step is to draw a time diagram like Fig. 13-3. The common point in time for the two alternatives is 60 years, so two cycles of A should be compared with three cycles of B.

Present-worth analysis:

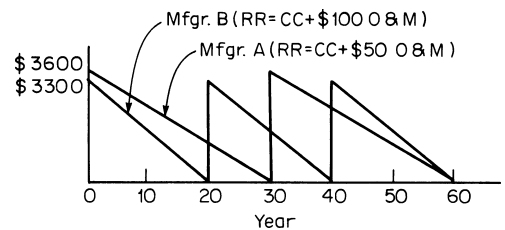


FIGURE 13-3 Time diagram.

$$\begin{aligned}
 \text{PW Mfr. A's alternative} &= 3600 \times 0.1496 + 11.258 + 50 \times 11.258 \\
 &+ (3600 \times 0.1496 \times 11.258 + 50 \times 11.258) 0.0994 \\
 &= 6063.11 + 562.90 + 658.63 \\
 &= \underline{7284.64}
 \end{aligned}$$

$$\begin{aligned}
 \text{PW Mfr. B's alternative} &= 3300 \times 0.1604 \times 9.818 + 100 \times 9.818 \\
 &+ (3300 \times 0.1604 \times 9.818 + 100 \times 9.818) 0.2145 \\
 &+ (3300 \times 0.1604 \times 9.818 + 100 \times 9.818) 0.0460 \\
 &= 5196.86 + 981.80 + 1325.32 + 284.22 \\
 &= \underline{7788.20}
 \end{aligned}$$

where 3600 = installed cost of Mfr. A's switch

0.1496 = level annual carrying charge for 30-year A switch

11.258 = 8%, 30-year uniform annual series present-worth factor

50 = $O\&M$ of A's switch

0.0994 = 8%, 30-year single-payment present-worth factor

3300 = installed cost of Mfr. B's switch

0.1604 = level annual carrying charge for 20-year B switch

9.818 = 8%, 20-year uniform annual series present-worth factor

100 = $O\&M$ of B's switch

0.2145 = 8%, 20-year single payment present-worth factor

0.0460 = 8%, 40-year single payment present-worth factor

Manufacturer A's switch would be the overall lowest cost and would be the better deal provided the capability and reliability of the two switches are equivalent.

13.3 DECISION CRITERIA

There are two measures of the relative worth of projects—the net spendable *amount* of the return (the NPV) and the rate of return on the investment required. The latter measure is the *internal rate of return*. Mathematically, the internal rate of return is the discount rate at which the present value of the cost stream (including both original investments and subsequent costs) equals the present value of the revenue stream. The internal rate of return of the preceding project is obviously greater than 10%, since the NPV is positive at a 10% discount rate. If the NPV had been negative, then it would have been obvious that the internal rate of return was less than 10%.

A decision criterion often used to discriminate between projects is the *payback period*, or *payback*. Mathematically, the payback period is the *cost of the improvement* divided by the *average annual savings*. Although first-year savings are sometimes used as the divisor, the average savings should be used and should include escalations over the life of the project. Using only the first-year savings can yield an incorrect payback.

The following discussion demonstrates that a payback criterion often can lead to the wrong conclusion. If cash stream A and cash stream B of Table 13-2 were both “savings” streams resulting from the investment of \$400 in projects A and B, respectively, the payback would mathematically be the same for each project because they have the same total savings. The average savings (income) is \$650 divided by 4 years, or \$162.50 per year. The payback for each project is the \$400 investment divided by the average annual savings of \$162.50, or almost 2.5 years. However, the NPV of each is not equal. The NPV of project A is \$100 (\$500 to \$400); project B’s NPV is \$130 (\$530 to \$400). The time value of money causes project B to clearly be the better project; the payback criterion fails to differentiate between the two.

Because of the time-value-of-money problem, a payback criterion actually can indicate that a lesser project is better. For example, if the 1987 savings of project A increased from \$220 to \$240, the NPV of the project would increase from \$100 to \$114. Clearly, project B with an NPV of \$130 is still better, if the discount rate is 10%. However, the payback period for project A would now decrease from 2.5 to 2.4 years; as a result, the wrong project would be picked if a payback criterion is used.

The type of payback discussed earlier is called a *simple payback* because it uses nominal-year dollars in the calculations. If real (constant-year) dollars are used, it is called the *discounted payback period* or the “breakeven period.” In the preceding example, using a discounted payback criterion would have indicated the correct choice in both cases. In Table 13-2, the average discounted savings for projects A and B would be \$125 [\$500 present value (PV)/4 years] and \$132.50, respectively; the discounted paybacks would be 3.2 years (\$400/\$125/year) and 3 years, respectively. Project B would be chosen because of its shorter payback period.

If the year 4 savings of project A increased to \$240, the PV of savings would only increase to \$514. Since this would still be less than the PV of \$530 for the savings from project B, project A would have lower average discounted savings and a longer discounted payback than project B; the correct relative choice would be made. It is clear that if paybacks are used at all, the discounted payback should be used.

Although the preceding illustration shows the possible folly in looking only at nominal numbers, Table 13-3 and Fig. 13-4 show that folly even better. Both project X and project Y require a \$1000 initial investment. It should be clear from Table 13-3 that project Y is the better of the two investments. It would be chosen whether the decision criterion was NPV, internal rate of return, calculated discounted paybacks, or calculated simple paybacks. However, if the first-year savings is used in the payback calculation, or if actual payback time (see the graph) is used, project X would be chosen. This shows the problem with using first-year savings instead of average savings; it also brings up another important point. It is *cash flows* which dominate business decisions; both the level and the timing of those flows can be critical. Project X could very well be the appropriate project to choose if the timing of its cash flows allowed other projects to be undertaken such that the aggregate benefit of all projects was increased. The final decisions on projects should be made on an overall benefit basis.

Another useful tool for comparing projects is the *benefit-cost ratio*, which is the present value of the benefits (savings) divided by the initial cost. For projects X and Y of Table 13-3, the benefit-cost

TABLE 13-3 Net Present Value vs. Payback (\$1000 original investment, 10% discount rate)

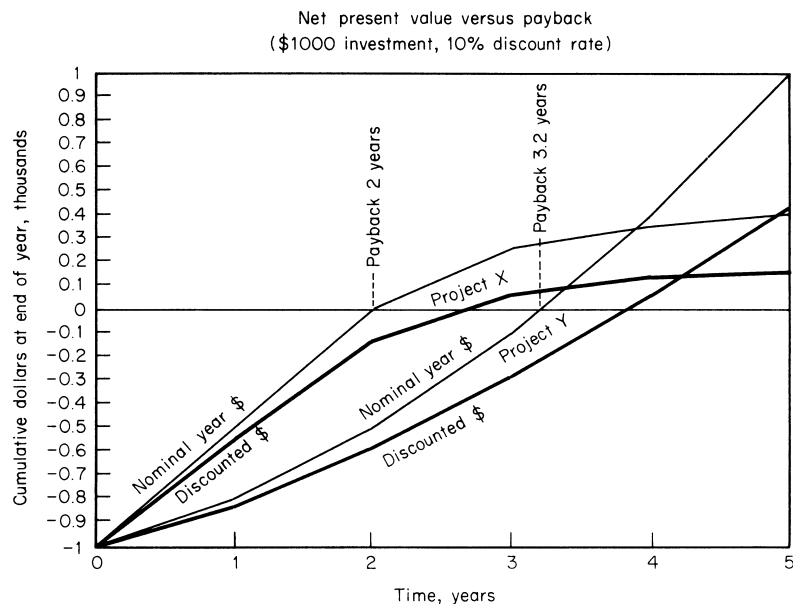
Project	Net cash returns by year					Project return				
	1	2	3	4	5	Nominal \$		Discounted \$		%IRR*
						Total	Net	PV	NPV	
X	500	500	250	100	50	1400	400	1155	155	18.5
Y	200	300	400	500	600	2000	1000	1444	444	23.3

Project	Simple payback, year			Discounted paybacks, year	
	Calculated using				
	1st-year savings	Average savings	Actual payback	Calculated	Actual
X	2.0	3.6	2.0	4.3	3.5
Y	5.0	2.5	3.2	3.5	3.8

*IRR = internal rate of return.

ratios are 1.155 and 1.444, respectively. When the appropriate discount rate is used, any benefit-cost ratio greater than unity (1.0) indicates that the project is profitable.

Calculating the NPV and the internal rate of return from each alternative project is a rational method of discriminating between projects and ranking them in an investment priority. First, the projects can be ranked in descending order by the internal rates of return. With an unlimited amount of money and management time, a company would be expected to start all projects with an internal rate of return greater than the cost of money to the company. However, in the "real world," this is usually not the case. The firm is usually limited in capital, or in management capability, and must choose a

**FIGURE 13-4** Graph of net present value vs. payback (values from Table 13-3).

subset of the complete menu of alternative projects. The NPVs of the projects can be used to help match available resources to achieve the greatest total real return.

In addition to the consideration of the real income and the real rates of return from the various projects, the nominal-dollar flows of each project must be considered to ensure that the cash flow of the company will be great enough to provide the capital needed in each time period.

If the total cash outlay required for all projects is greater than the total income during any period, the company must either borrow the shortfall or pay it out of available cash. For many companies, available cash is tight, and expected business conditions are not good or are uncertain. These companies will rarely invest in a set of projects that may put them in financial jeopardy—even if the expected long-term returns are great. It is not unusual for a low-return project to be substituted for a high-return project when the cash requirements of the high-return project coincide with other cash demands and the company cannot economically provide the required funds at that time.

The example in Table 13-3 is simplistic. It incorrectly assumes that (1) the project costs and returns are certain and (2) all proceeds of the project can be retained by the owner. Uncertainty of cash flows should be considered by using “sensitivity analysis” and comparing expected results under both optimistic and pessimistic conditions. The tax consequences of the manner in which a project is financed are discussed in the next sections. Further comments on the characteristics affecting the type and amount of an investment are provided at the end of this primer.

13.4 AFTER-TAX CASH FLOWS

The net amount of cash available for reinvestment in the company or distribution to the owners depends on the tax consequences of a project and its financing. For tax purposes, there are two kinds of project expenditures—expensed and capitalized. Expenditures for short-lived items consumed in making a product or providing a service are generally allowed to be “expensed” in the year they are made. Such expenses are allowed to be deducted from gross income before taxes are computed. Examples are rent, parts, travel expenses, utility bills, raw materials, labor, and advertising.

Capitalized expenditures will continue to give service for several years. The company is allowed to recover those expenses over a number of years by deducting a percentage of the cost each year from the gross income of the company before calculating the taxes. This “depreciation recovery” follows specific rules for the number of years over which the recovery is made and the percentage of the cost allowed as a tax deduction each year.

Typical capitalized expenditures are buildings, machinery, and land. Since buildings and machinery are “consumed” in service, they are considered depreciable property. Land, however, is not consumed and cannot be depreciated except under special circumstances, such as where the usefulness of the land is indeed consumed and a depletion allowance is authorized.

Deductions have no value in themselves; they merely serve to reduce the amount of income that is taxable. As a result, the actual value of an allowed expense or depreciation deduction depends on the *incremental tax rate* of the company. This is the rate charged against the “last” income earned in a year. Since a tax deduction offsets or “shelters” income by reducing the taxable income, the value of a tax deduction is the amount of tax that would have been paid on the income that is sheltered by the deduction. The higher the incremental tax rate, the greater the tax expense avoided by taking the deduction. The reduction in income taxes that *results* from allowed deductions has the same effect as an increase in project revenues; each increases the net revenues of the project. (*Note:* Deductions are not cash items and are not spendable income; their value is that they generate savings in taxes that otherwise would have to be paid.)

Most projects qualify for one or more special tax subsidies called *tax credits*. A tax credit can offset a tax otherwise owed to the government; the actual cash required for paying taxes is thus reduced. Tax credits are usually in the form of a stated percentage of the capitalized project investment and are usually allowed only in the year of the investment. Unlike allowed depreciation, the effect on the company from a tax credit is independent of the incremental tax rate. The tax credit is a direct reduction in the tax liability of the company. If the tax credit is greater than the tax liability in that year, the unused portion can be applied in other years.

TABLE 13-4 Tax Calculation

Gross income
– interest payments
– operating expenses
– allowable amortization and depreciation on equipment
– other tax-deductible expenses
= taxable income (+ or –)
× incremental tax rate
= initial tax liability (+ indicates due, – indicates saved)
– total tax credits (only if tax liability is positive)
= actual tax (+ indicates due, – indicates saved)

Note: Taxable income is the net difference between gross income and allowed deductions. Since taxable income determines the actual tax liability, it is easy to see the effect on after-tax income of increasing or decreasing the allowed deductions.

The net cash flow in spendable dollars yielded by a project depends on the gross income and the cash expenditures which must be made as a result of the project. The tax effects of the investment and the method of financing the investment can sometimes “make or break” a project. Table 13-4 shows the items that must be considered when calculating tax liabilities.

Table 13-5 shows two methods of calculating the effect of taxes on cash flow; both yield the same answer. These methods are presented here to aid in understanding the effect of nondeductible expenses and noncash tax deductions on the cash flow of a given year. Principal payments on loans are not allowed as a tax deduction, but they are cash payments that must be made during the year. On the other hand, depreciation on depreciable assets is allowed as a tax deduction, and therefore reduces taxes, but it is not an out-of-pocket cash expenditure.

TABLE 13-5 Cash Flow Calculations

Method 1
Taxable income
– principal payments on debt
+ allowable amortization and depreciation (these are noncash-deductible expenses and, as such, are not spent but available)
= cash available for taxes
– tax due (or + tax savings)
= after-tax cash income
Method 2
Gross income
– interest payments
– principal payments
– other cash expenses
= cash available for taxes
– tax due (or + tax savings)
= after-tax cash income

Note: These calculations assume that the total income of this project and other projects is great enough for the owner to use all of the benefits earned in this year. Otherwise, some of the benefits may be carried into another tax year—but they will be worth less because of the time value of money.

13.5 FINANCING EFFECTS

The examples in Table 13-6 show the tax benefits that result from changing the method of financing a project. The project requires an initial investment of \$4000. If as in line 1 the owner finances the whole project with personal equity funds, without borrowing any funds and going into debt, the only tax deduction allowed over the life of the project is the depreciation expense. Since both the tax credits and the depreciation expense are related only to the cost of the depreciable assets, and not to the method of financing, both are the same in all cases. If the owner has a 50% incremental tax rate, the allowed deductions generate \$2000 in tax savings if the project is 100% equity-financed. The resulting tax benefits total 60% of the original equity investment.

If the owner borrows \$1000 and invests \$3000 of his or her own money, that is, finances the project in a 25:75 debt-equity ratio, the allowed tax deductions rise by the \$492 interest deduction, and the tax benefits increase. Financing part of a project with debt funds is called *leveraging* the equity investment. All the benefits of the project continue to flow to the owner, and the tax benefits themselves increase. As a result of the increased benefits and the decreased equity investment, the ratio of tax benefits to equity increases; the rate of return on the investment thus increases, even though the project itself is bringing in the same gross income.

If the project is financed with a 75:25 debt-equity ratio, the tax benefits which accrue to the owner amount to over 3 times its original equity investment. There are no free lunches, however. If the project fails to reach its income objectives, or costs run higher than expected, the owner will still be liable for payment of the principal and interest payments on the money borrowed for the project. The higher the leverage of the investment in the project, the higher is the business risk the owner faces.

Table 13-7 contains the data for the illustrations of financing effects in the remaining tables. The payments for principal and interest are shown for a debt of \$1000 to be repaid over 5 years at 15% interest. The depreciation rates allowed under the accelerated cost recovery system (ACRS) are shown along with the annual depreciation and the investment tax credit allowed on a \$2000 depreciable investment. The tables in this text were prepared using 1982 regulations and have been retained for simplicity of illustration. Since tax credits and tax deductions change frequently, care should be taken to use the correct allowances.

Table 13-8 shows the calculations of tax effects and cash flows for a \$2000 project which the owner finances completely with equity investment. There are no interest deductions included in the tax calculations, since there is no debt to repay. Likewise, there are no principal payments included in the cash flow calculations. The incremental income tax rate of the owner is assumed to be 50%. This method of financing the project yields a nominal return of \$4434 over 5 years from an original investment of \$2000. The internal rate of return is 32.6%.

Table 13-9 shows the same project, except that it is now financed with 50% equity and 50% debt, with the debt cost assumed at a rate of 15% per year. A 50:50 debt-equity ratio increases the cash outflow required to service the debt; it reduces the overall nominal return over the 5 years to \$3187. However, since the owner invested only \$1000, the internal rate of return of the project increases to the 55% level. This indicates that if the owner had \$2000 to invest, it would be better (other things

TABLE 13-6 Examples of Tax Benefits

Total tax benefits received by owner of a \$4000 project

Percent equity financing	Owner equity investment, \$	Amount borrowed, \$	Depreciation expense deduction, \$	Interest expense deduction \$ 15%, \$	Total deductions, \$	Taxes saved @50%, \$	Inv. tax credits, \$	Total cash benefits, \$	Ratio tax benefits-equity
100	4000	0	4000	0	4000	2000	400	2400	0.60
75	3000	1000	4000	492	4492	2246	400	2646	0.88
50	2000	2000	4000	983	4984	2492	400	2892	1.45
25	1000	3000	4000	1476	5476	2738	400	3138	3.14

TABLE 13-7 Data for Illustrations in Tables 13-8 through 13-14
 Payments based on \$1000 borrowed for 5 years at 15% interest

	Annual cash payments by year, \$					Total
	1	2	3	4	5	
Interest (tax-deductible)	150.00	127.75	102.17	72.75	38.91	491.58
Principal (not deductible)	148.32	170.57	196.15	225.57	259.41	1,000.02
Payment	298.32	298.32	298.32	298.32	298.32	1,491.60

	Year				
	1	2	3	4	5
ACRS depreciation rates, %	15	22	21	21	21
Allowed depreciation deduction on \$2000	300	440	420	420	420
10% investment tax credit (not deduction)					
First year only	200				

Note: Assumed combined federal and state tax rate = 50%

TABLE 13-8 100% Owner Financing of a \$2000 Project

	Year					
	1	2	3	4	5	Total
Tax calculations						
Revenues	1500	1680	1880	2100	2360	9520
– interest	0	0	0	0	0	0
– O&M expenses*	500	550	605	666	732	3053
– depreciation	300	440	420	420	420	2000
= taxable income	700	690	855	1014	1208	4467
× tax rate	0.50	0.50	0.50	0.50	0.50	0.50
= initial tax due	350	345	427	507	604	2233
– tax credits	200	0	0	0	0	200
= actual tax due	150	345	427	507	604	2033
Cash flow						
Taxable income	700	690	855	1014	1208	4467
– principal payments	0	0	0	0	0	0
= depreciation	300	440	420	420	420	2000
= cash available	1000	1130	1275	1434	1628	6467
+ tax due	150	345	427	507	604	2033
= after-tax cash income	850	785	848	927	1024	4434

Note: The original owner investment of \$2000 returns over \$4000 in 5 years for an internal rate of return of 32.6%.

*Operation and maintenance.

TABLE 13-9 50% Debt and 50% Owner Financing of a \$2000 Project

	Year					Total
	1	2	3	4	5	
Tax calculations						
Revenues	1500	1680	1880	2100	2360	9520
– interest	150	128	102	73	39	492
– O&M expenses	500	550	605	666	732	3053
– depreciation	300	440	420	420	420	2000
= taxable income	550	562	753	941	1169	3975
× tax rate	0.50	0.50	0.50	0.50	0.50	0.50
= initial tax due	275	281	376	471	585	1988
– tax credits	200	0	0	0	0	200
= actual tax due	75	281	376	471	585	1788
Cash flow						
Taxable income	550	562	753	941	1169	3975
– principal payments	148	171	196	226	359	1000
+ depreciation	300	440	420	420	420	2000
= cash available	702	831	977	1135	1330	4975
– tax due	75	281	376	471	585	1788
= after-tax cash income	627	550	601	664	745	3187

Note: The original owner investment of \$1000 returns over \$3000 in 5 years for an internal rate of return of 54.5%.

Leveraging the owner's equity investment 1:1 with debt causes the internal rate of return on the owner's equity investment to rise because the owner invests only half the money but still receives the full tax benefits.

being equal) to invest \$1000 each in two such projects. The yield would then be \$6374 for a \$2000 investment, as compared with \$4434 if only one project is completely owner-financed.

Table 13-10 shows that the same project, with a 30% owner tax rate, yields \$3982 in income for the \$1000 initial investment. (*Note:* All the tax credit could not be used in the first year because the tax liability was reduced by the lower tax rate.)

TABLE 13-10 50% Debt and 50% Owner Financing of a \$2000 Project, with an Owner Tax Rate of 30%

	Year					Total
	1	2	3	4	5	
Tax calculations						
Taxable income	550	562	753	941	1169	3975
× tax rate	0.30	0.30	0.30	0.30	0.30	0.30
= initial tax due	165	169	226	282	351	1193
– tax credits	165	35	0	0	0	200
= actual tax due	0	134	226	282	351	993
Cash flow						
Cash available	702	831	977	1135	1330	4975
– tax due	0	35	226	282	351	993
= after-tax cash income	702	697	751	853	979	3982

13.6 LEASING

When a lease arrangement is worked out between two parties, the lessor party owns the installation, and the lessee party pays for its use. Since the lessee must pay enough profit to the lessor for the lessor to be willing to install the property for the lessee's use, this arrangement might not appear advantageous to the lessee. However, leasing can be a great advantage in several situations, particularly when the lessee does not want to or cannot borrow the initial money required. The tax advantages of a lease often make a project *go* with lease financing when it cannot go otherwise. Tables 13-11 to 13-14 examine the cash flows that occur in a leasing situation.

Table 13-11 calculates the revenue required for the lessor to recover its expenses and investment *without* any return, that is, to break even, if it installs the project and leases it to a lessee. In this particular case, the lessor would make no profit and there would be no incentive to install the project. This case is shown only for the purpose of having a clean example to use as a base for leading into the following examples. Table 13-11 shows the effect of the tax deductions on the lessor; it also shows the out-of-pocket expenses of the lessor that must be covered by the lessee if the lessor breaks even. This is essentially the same set of calculations shown in Table 13-9, except that Table 13-11 calculates the breakeven point.

If the lessor breaks even, Table 13-12 shows the return to the lessee from leasing the project from the lessor. In this case, the lessee invests no money in the project and still reaps a handsome reward. One of the mechanisms that makes leasing work is that the lessee can take the entire cost of the lease as a deduction before taxes, *including the cost of the principal payments of the lessor*. If the lessee were to put the project in on its own, as in Table 13-9, it could deduct only depreciation and interest payments. By leasing, the lessee gets, in effect, two bites at the apple; it gets to deduct the entire

TABLE 13-11 Required Breakeven Revenue for Lessor for \$2000 Project with 50:50 Debt-Equity Ratio

	Year					
	1	2	3	4	5	Total
Tax calculations						
Interest	150	128	102	73	39	492
+ O&M expenses	500	550	605	666	732	3053
+ depreciation	300	440	420	420	420	2000
= deductible expenses	950	1118	1127	1159	1191	5545
× tax rate	0.50	0.50	0.50	0.50	0.50	0.50
= initial taxes saved	475	559	563	580	595	2772
+ tax credits	200	0	0	0	0	200
= actual taxes saved	675	559	563	580	595	2972
Cash flow						
Interest & principal	298	299	298	299	298	1492
+ O&M expenses	500	550	605	666	732	3053
− tax savings	675	559	563	580	595	2972
= operating cash outlay	123	290	340	385	435	1573
+ investment recovery	200	200	200	200	200	200
= required cash	323	490	540	585	635	2573
× 2 (tax factor)						
= required revenue	646	980	1080	1170	1270	5146

TABLE 13-12 Income of Lessee if Lessor Breaks Even

	Year					
	1	2	3	4	5	Total
Tax calculations						
Revenues	1500	1680	1880	2100	2360	9520
<u>– lease payment</u>	<u>646</u>	<u>980</u>	<u>1080</u>	<u>1170</u>	<u>1270</u>	<u>5146</u>
= taxable income	854	700	800	930	1090	4374
<u>× tax rate</u>	<u>0.50</u>	<u>0.50</u>	<u>0.50</u>	<u>0.50</u>	<u>0.50</u>	<u>0.50</u>
= tax due	427	350	400	465	545	2187
Cash flow						
Revenues	1500	1680	1880	2100	2360	9520
– income taxes	427	350	400	465	545	2187
<u>– lease payment</u>	<u>646</u>	<u>980</u>	<u>1080</u>	<u>1170</u>	<u>1270</u>	<u>5146</u>
= after-tax cash income	427	350	400	465	545	2187

Note: The long-run economics of leasing would depend upon the terms of the lease and the residual ownership and use of equipment after initial payoff.

TABLE 13-13 Required Lessor Revenue if Lessor Makes 15% on Investment on a \$2000 Project with 50:50 Debt-Equity Ratio

	Year					
	1	2	3	4	5	Total
Tax calculations						
Interest	150	128	102	73	39	492
+ O&M expenses	500	550	605	666	732	3053
+ depreciation	<u>300</u>	<u>440</u>	<u>420</u>	<u>420</u>	<u>420</u>	<u>2000</u>
= deductible expenses	950	1118	1127	1159	1191	5545
× tax rate	<u>0.50</u>	<u>0.50</u>	<u>0.50</u>	<u>0.50</u>	<u>0.50</u>	<u>0.50</u>
= initial taxes saved	475	559	563	580	595	2772
+ tax credits	<u>200</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>200</u>
= actual taxes saved	675	559	563	580	595	2972
Cash flow						
Loan payment ($i + p$)	298	299	298	299	298	1492
+ O&M expenses	500	500	605	666	732	3053
− tax savings	<u>675</u>	<u>559</u>	<u>563</u>	<u>580</u>	<u>595</u>	<u>2972</u>
= operating cash outlay	123	290	340	385	435	1573
+ recovery of initial investment						
@ 15% return	<u>298</u>	<u>299</u>	<u>298</u>	<u>299</u>	<u>298</u>	<u>1492</u>
= required cash	421	589	638	684	733	3065
× 2 (the tax factor)						
= required income	<u>842</u>	<u>1178</u>	<u>1276</u>	<u>1368</u>	<u>1466</u>	<u>6130</u>

TABLE 13-14 Income of Lessee if Lessor Makes 15%

	Year					Total
	1	2	3	4	5	
Tax calculations						
Revenues	1500	1680	1880	2100	2360	9520
– lease payment	842	1178	1276	1368	1466	6130
= taxable income	658	502	604	732	894	3390
× tax rate	0.50	0.50	0.50	0.50	0.50	0.50
= tax due	329	251	302	366	447	1695
Cash flow						
Revenues	1500	1680	1880	2100	2360	9520
– income taxes	329	251	302	366	447	1695
– lease payment	842	1178	1276	1368	1466	6130
= after-tax cash income	329	251	302	366	447	1695

Note: With a zero investment by the lessee, the lessor makes a 15% return and the lessee still makes \$1695, an infinite return. The long-run economics of leasing would depend upon the terms of the lease and the residual ownership and use of equipment after the initial payoff.

lease payment before taxes. Since the lease payment includes both the principal payments and the tax effects of depreciation allowances, the lessee, in effect, gets to write off the project twice, once at the lessor's incremental tax rate and once at the lessee's incremental tax rate.

Table 13-13 is the same as Table 13-11, except that Table 13-13 calculates the revenue required to produce a 15% return on investment for the lessor, rather than a breakeven return. Required income almost doubles, primarily because of the income taxes that have to be paid on taxable income before the net cash is available to the lessor.

Table 13-14 shows that the effect of allowing the lessor to earn a 15% rate of return is to cut the lessee's after-tax income roughly in half. However, since the lessee still hasn't invested any money in the project, the rate of return of the lessee is infinitely large. When the return of \$1695 from leasing is compared with the return of Table 13-9, where an initial investment of \$1000 is required, the attractiveness of many leasing schemes is immediately seen. When such schemes are combined with provisions for the lessee to be able to buy the project from the lessor in the future at a reasonable price and at lessee's option, the package can be especially attractive.

In some cases, leasing is used to protect the lessee from buying a set of equipment that may not work well for its application. By leasing, the lessee gets a chance to work with the equipment and see if it performs as expected—before spending large amounts of investment capital on the installation.

13.7 RATE-OF-RETURN REQUIREMENTS

There are three components of *interest rates*. The first is the *liquidity factor*. There is a value in having cash available to use for whatever investment opportunity may appear in the future. Before one person will lend money to another, the interest earned must compensate the lender for the unavailability of its money while the borrower still has it, that is, for the lack of liquidity. Second, just like one neighbor lending another a lawn mower, the lender of money expects to get it back in just as valuable a condition as when it was borrowed. In the case of money, the borrower must increase the interest rate paid to the lender enough to include the expected rate of *inflation*. This allows the lender to recover the same *value* as originally lent, albeit a greater number of dollars. The third item that must be included in the interest rate, before a lender is willing to part with the money, is enough additional interest to offset any

risks associated with the loan. Obviously, the riskier a loan appears, the higher the interest rate required by the lender will be. All of these factors entail *uncertainty*. The lender is uncertain about what opportunities may come along later, the devaluation of the loan from inflation, the ability of the lender to repay the loan, changes in government regulations, and other factors.

These same factors influence the *minimum expected rate of return*, or the *hurdle rate*, that a company requires a project to meet or exceed before giving it full consideration. If the company must borrow money to finance the project, it will be concerned about its ability to repay the loan without jeopardizing the company. The very financing methods which leverage a company's investment and produce such high possible returns also leverage the company's financial risk. Usually, the more stable the expected earnings from projects, the more leverage the company is willing to risk.

If a hurdle rate is used to screen potential projects, the hurdle rate should appropriately reflect the weighted cost of capital to the firm. Using a hurdle rate that is significantly different from the weighted cost of capital incorrectly rejects and accepts projects.

It is not correct to use either the opportunity cost of using retained earnings or the interest rate on borrowed debt solely as the hurdle rate. If retained earnings are used in one project, they are unavailable for use in others. The opportunity cost of using those funds is the rate of return that could be earned by investing those funds in routine company business opportunities. As such, they are generally both higher cost and less extensive than available debt funds. Using that rate can deny worthwhile projects and choke the expansion of the firm.

Considering a project to be financed entirely by debt is also unrealistic. If funds are borrowed without a complementary equity investment, the debt-equity ratio rises, the debt coverage ratio falls, and the ability to borrow more funds decreases.

As a result of the above and related factors, the appropriate hurdle rate is the weighted cost of capital to the firm.

Hurdle rates are often used both as a threshold of profitability that projects must meet and as a method of discriminating *between* projects. As stated earlier, using a hurdle rate that is significantly different from the actual cost of capital to the firm will undercommit or overcommit the firm. As shown below, it may also lead to an incorrect choice of projects.

If all projects under consideration have positive cash flows in later years, almost any hurdle rate can be used to determine the "best" projects on a relative NPV basis. The higher the hurdle rate used to discount future cash flows, the lower the resulting NPV. The result may be the wrong NPV, but the relative ranking will not change. However, that is *not* the case where one or more of the projects have some later years with negative cash flows, such as when significant investments in maintenance or replacement are required; relative rankings may change.

In effect, the discount rate used as a hurdle is assumed to be a rate that can continue to be earned in other areas by the dollars returned from a project each year. It can be used to pay off debt and "earn" the avoided interest, or it can be put into another income-producing project. In addition, the higher the discount rate, the less value are later revenues. It is these effects which require the hurdle rate to be close to the actual cost of capital. If a firm cannot actually earn the hurdle rate by reinvesting each year's proceeds from a project, the wrong project may be chosen.

13.8 CHARACTERISTICS AFFECTING INVESTMENTS

The preceding discussions have briefly covered some of the factors that drive the decisions people make about new projects and affect the amounts and types of investments. The following is a summary of items that must be considered when any major project is examined:

- Ability to borrow money
- Cash on hand
- Relative risk of the project
- Ability to use tax benefits
- Existence of tax credits or unusual benefits or constraints

Relative tax rates
Timing of the costs and revenues
Relative permanence of the investment
Ability to shift to another investment if one becomes more attractive
Ability to maintain and operate the project equipment

The ability of a party with money and a party with a project need to find a satisfactory arrangement for (1) financing the project and (2) appropriately sharing the risks and the benefits is almost limitless. Both parties (they may be the same party if the project is primarily owner-financed) must find an acceptable level of risk and reward.

13.9 RISK AND REWARD

To many people, taking a risk is its own reward; to others, very little risk is worth taking. The successful manager will analyze alternative projects and will adjust project parameters and financing methods to yield combinations of risk and expected reward appropriate for all parties.

The successful project analyst will be guided by the TANSTAAFL principle: *There ain't no such thing as a free lunch*. Someone, somewhere pays for everything. The questions are who? how much? and when? Answering these provides the basis for sound decisions.

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